



Lab Test Phase: Preliminary Results Shipboard Evaluation Phase: Plans

California ARB
Maritime Air Quality Technical Working Group

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Overview

- Lab Test Objectives and Scope
- Lab Test Results
- Shipboard Evaluation Plans
- Summary

Objectives

- Evaluate emission control cost effectiveness: legacy DDC 2-S engines
- Assess performance of 5 fuels and 5 technologies
- Investigate combination synergies
- Compare PM measurement methods
 - Gravimetric « characterization



Background

➔ **contribution to Navy mission**

- Environmental quality core component of 21st Century Fleet
- Identify measurement tools to yield high quality Navy data
- Safeguard Navy's most valuable asset –sailors and their health
- Quantify conformity options

Approach

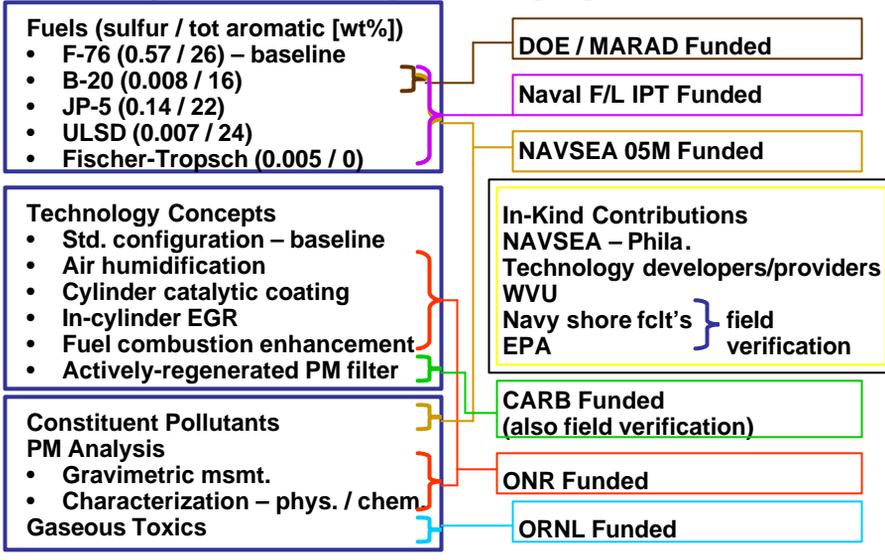
- Broad partnership: industry & regulators
- ISO 8178 protocol, E5/D2 cycles
- Performance
- Criteria emittents
- PM physical/chemical
- Aldehydes & organics



Accomplishments

- Completed all but one planned test
- Catastrophic engine failure brought lab test phase to early conclusion
- Test data reduction largely completed

Program funds/scope leveraging for NPECP

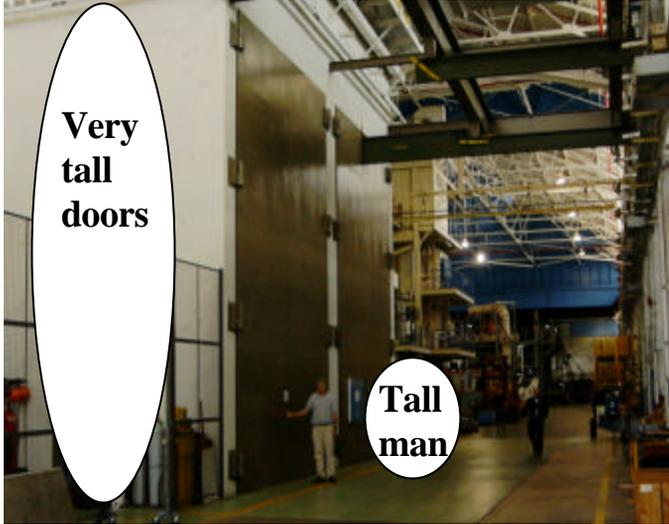


NAVSEA Marine Diesel Engine Test Facility Lab



**4,000 bhp
 medium-
 speed
 engine size
 capability**

NAVSEA Marine Diesel Engine Test Facility

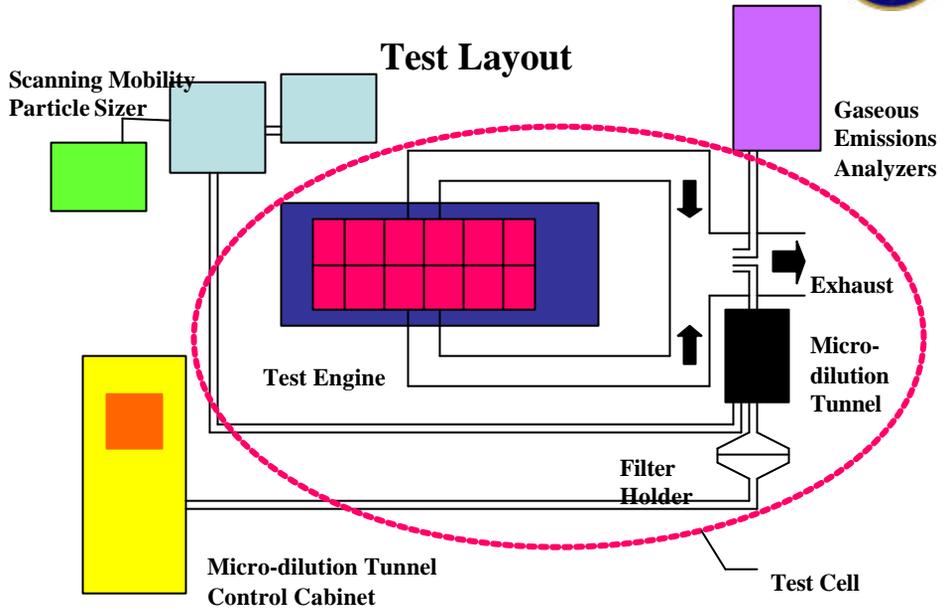


Very tall doors

Tall man

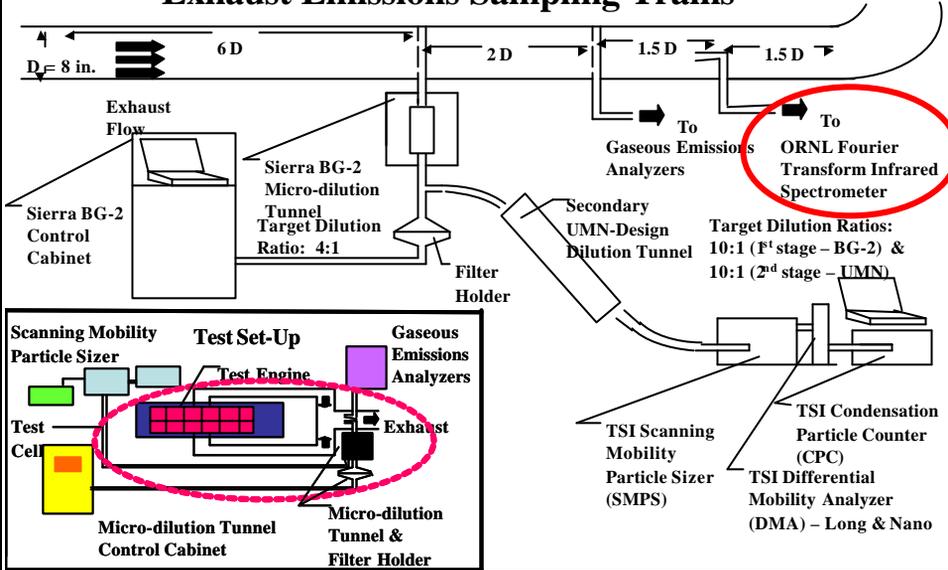
Exterior of 2 adjacent test cells

Test Layout

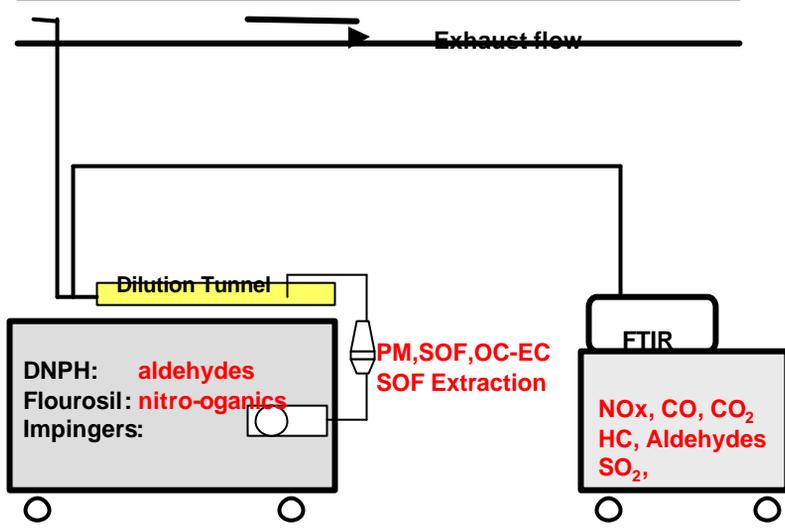




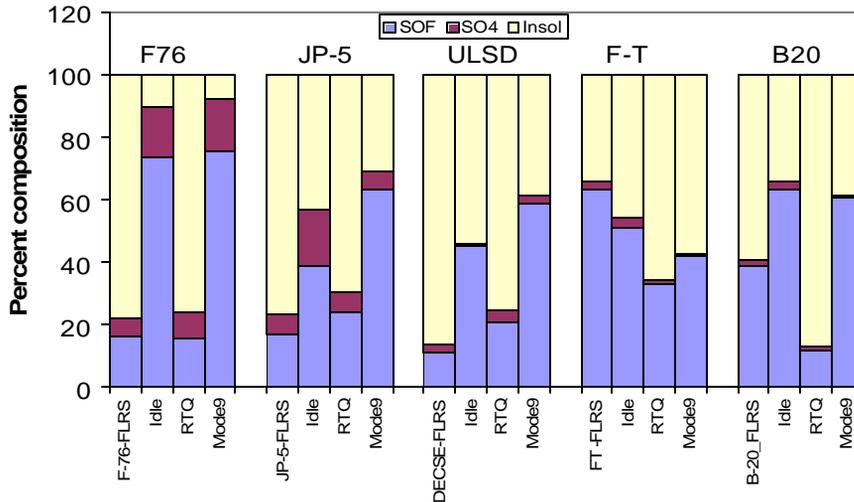
Exhaust Emissions Sampling Trains



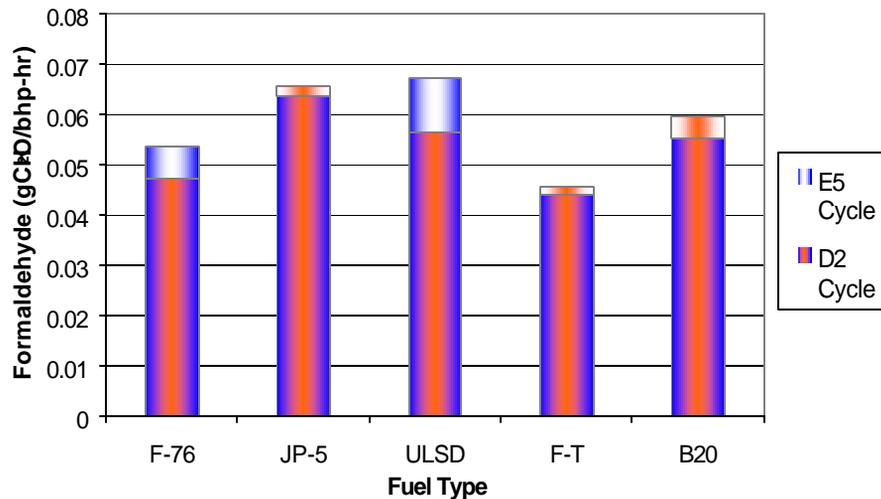
ORNL Sampling Train and Analytical Tools



Soluble Organic Fraction Results for Collected PM



Brake Specific Formaldehyde Levels

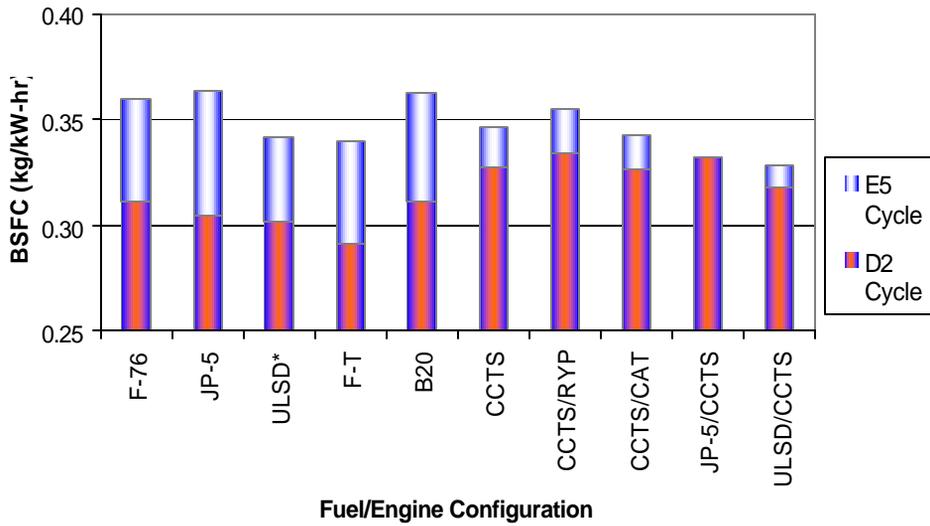




Navy Pilot Emission Control Prog. (NPECP)
Laboratory Test Phase
NAVSEA - Philadelphia



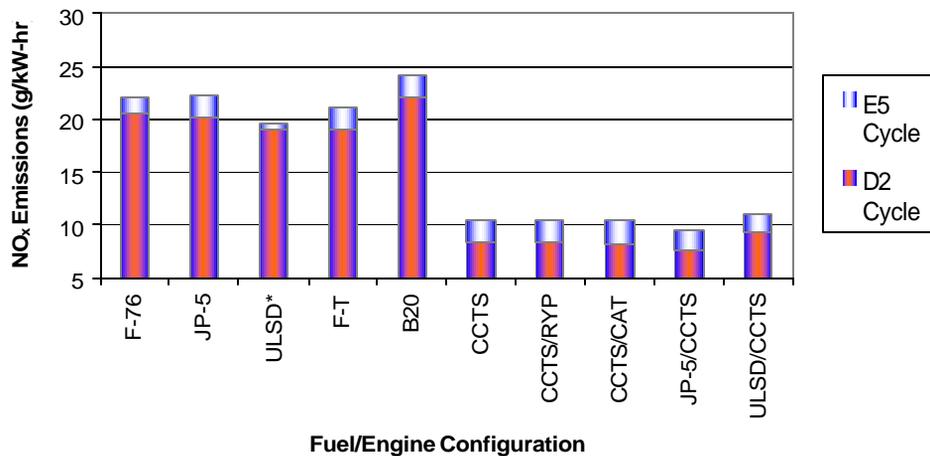
Brake Specific Fuel Consumption



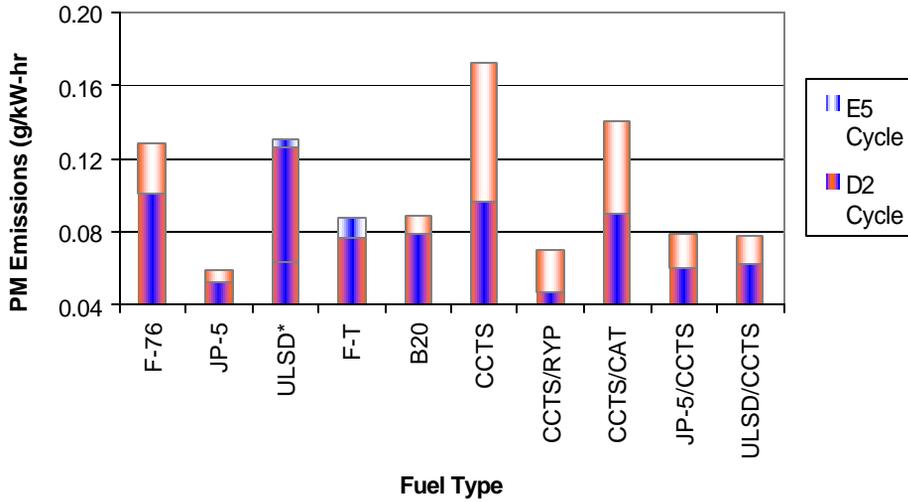
Navy Pilot Emission Control Prog. (NPECP)
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Brake Specific NOx Emissions

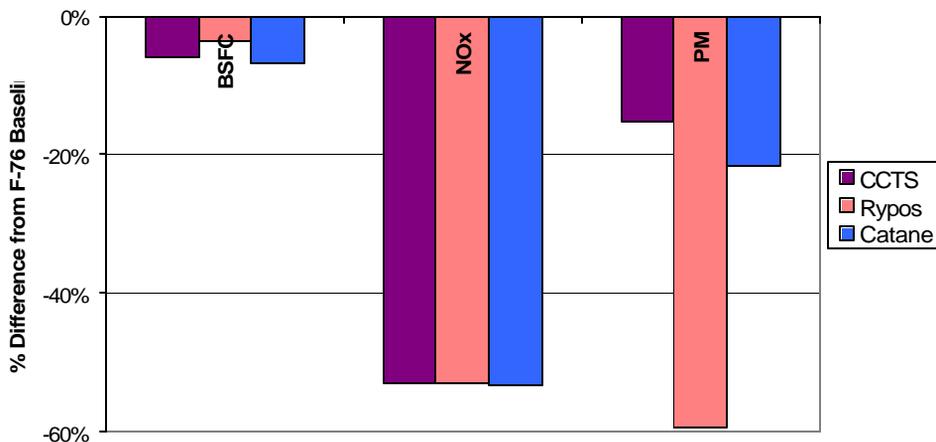


Brake Specific PM Emissions



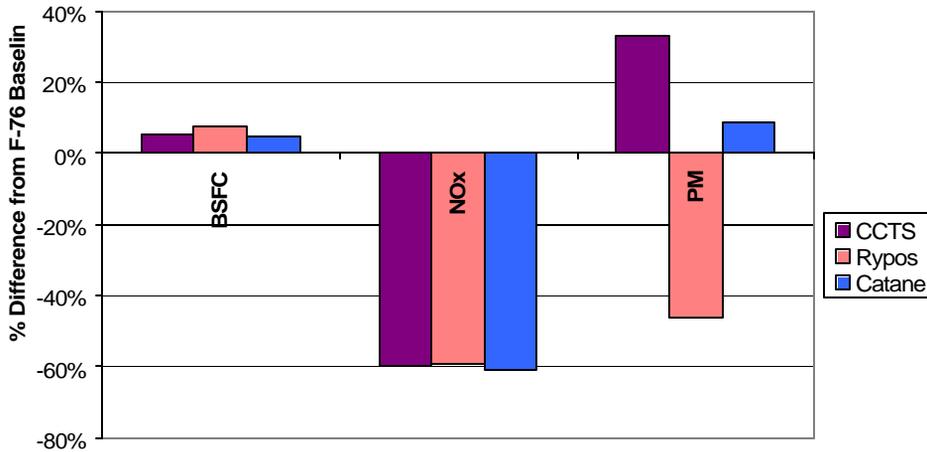
Comparison of Emission Control Technologies

Percent Difference from F-76 Baseline - E5 Cycle



Comparison of Emission Control Technologies

Percent Difference from F-76 Baseline - D2 Cycle



Objectives

- Real world reliability and durability evaluation
- Assess performance of 1 low sulfur fuel and 1-2 technologies



Background

- Maritime Administration (MARAD) YSD self-propelled barge crane
- High operating hour installation
- Propulsion: twin DDC 12V-71N engines
- Representative marine work boat load profile
 - 25% idle, 25% 30% load, and 50% 95% load

Approach

Continued partnership: MARAD, tech. providers, ORNL, & navy
Refurbish lab test engine for eval. engine
Baseline port propulsion engine
Switch out port engine w/ eval. engine
Break in eval. engine
Measure perf. and emis. of eval. engine
Operate for 6-9 mo.
Measure perf. and emis. degradation



Accomplishments

Completed one failure analysis
Engine ready to be shipped for
teardown/analysis
Initiated planning to coordinate

Summary

- For DDC 12V-72N, fuel substitution has mixed emissions results
- NO_x emissions
 - Little change: JP-5, F-T
 - Decrease: ULSD
 - Increase: B-20
- PM changes depend on load
- Formaldehyde increases with all but F-T



Summary

- WIS and Ecotip technologies not sufficiently developed for testing
- CCTS engine conversion resulted in anomalies
- Failures experienced with Rypos and CCTS
- Rypos failure explainable; CCTS still in progress
- Catane results inconclusive because of CCTS and Rypos problems
- Retrofit options and applications for legacy 2-S engines by no means straightforward



Marine Engine Exhaust Emissions POC



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